

The Examination and Comparison of Bolt Rotation Marks on Cartridges Cycled and Fired In Various 223 Caliber AR-15 Type Rifles

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ABSTRACT

If bolt rotation marks are the result of firing in, and not the result of cycling through the action, of a .223 caliber AR-15 type rifle, then the bolt rotation marks on fired cartridge cases would provide beneficial information to the firearm examiner regarding their examination of identifiable individual characteristics in the absence of a firearm. Seven AR-15 type rifles and three different brands of ammunition were used in this research. Cartridges were either fired or cycled through the action of each firearm. Bolt rotation marks were produced on both the cycled cartridges and the fired cartridge cases. These rotation marks could therefore only be used to determine that the tests were worked through the action of the firearms.

Introduction

Bolt rotation has been observed throughout the firearm identification community on ammunition components in various types of casework. The purpose of this research is to determine if bolt rotation marks are limited to being a result of firing or if they are also produced from a cartridge being cycled through a firearm. Any marks produced as a result of bolt rotation will be classified as to the cause, either by firing or cycling. These marks will be evaluated as to the quality and quantity of the individual characteristics that are left on the fired cartridge case or live cartridge. Determining if bolt rotation marks are only produced as a result of firing could aid a firearm examiner when fired cartridge cases are received in casework and in the absence of a suspect firearm. A firearm examiner could use the bolt rotation marks in the absence of other identifying characteristics to make the determination that the fired cartridge cases were fired in, and not just cycled through a firearm.

Operating Systems

The AR-15 rifle can be manufactured with either of two different types of gas-operating systems. The first type of system is called the direct-gas impingement (DGI) system. The DGI system uses the gas to push directly on the bolt carrier key to unlock the bolt and cycle the firearm. In this system, the bolt has two functions: it serves as a fixed piston and acts as a lock, with the bolt carrier acting as the sliding piston sleeve. The second type of gas-operating system is called the piston operating rod system, which uses a piston

operating rod, or op-rod. The op-rod is positioned forward of the bolt carrier and bolt carrier key. The gases push against the op-rod, which then pushes against the bolt carrier key, moving the bolt rearward and unlocking the bolt. The difference between the two systems is the design of the bolt carrier key. In the direct-gas impingement system, the bolt carrier key is hollow. This allows the gases to be used as a force to push the bolt rearward, unlocking it. In the piston operating rod gas system, the bolt carrier key is modified, having a solid stop for the op-rod to push against, moving the bolt rearward and unlocking it [1, 2].

The AR-15 rifle can be made as either a semi-automatic or fully automatic firearm; however this research project pertains only to the AR-15 semi-automatic rifle.

The AR-15 Bolt

The military specification for the AR-15 bolt requires Carpenter 158 steel, which is a low-carbon case-hardening type of steel. Case-hardening steel has a relatively softer inside encased in a harder steel outer shell.

The AR-15 bolt has four main functions during the cycle of fire. The first function is to strip a cartridge from the magazine, feeding the cartridge into the chamber. The second function is to rotate to lock into and unlock from the chamber during the cycle of fire. The third function of the bolt is to hold the extractor, which removes the cartridge from the chamber. The last function of the bolt is to house the ejector, which ejects the cartridge case from the rifle [3].

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Figure 1: Boltface Bushmaster 1

The general modern-day manufacturing process of the AR-15 bolt begins with a cylindrical bar stock of Carpenter 158 steel. The bar stock is fed into a screw machine. The screw machine, which is similar to a lathe, cuts and turns the bar stock, creating the shape and design of the AR-15 bolt. When the bolt is finished on the screw machine, it is almost manufactured to its proper dimensions. The bolt is heat treated and then goes through a finishing process. During the finishing process, the bolt is formed to the proper dimensions and is now ready for use in the rifle [3].

During the research phase of this project, two different manufacturers were contacted regarding how their AR-15 bolts were made. The manufacturing of the Smith & Wesson AR-15 (M&P 15) rifle bolt is outsourced. According to Jason DuBois at Smith & Wesson, the M&P 15 bolt, including the boltfaces, are manufactured using a screw machine. The lugs on the bolt are either broached or milled. The bolts are then carbonized/heat treated, shot peened, and checked for stress and cracks. In the last step, the bolts are coated with manganese phosphate [4]. According to Steve Mayor at Rock River Arms, their AR-15 bolts are manufactured by first using a screw machine, which forms the bolts into their final dimensions. The bolts are then heat treated. Once heat treated, four surfaces on the bolt are either hard part turned or ground for the finishing process. After the finishing process, the bolts are then coated [5].

Materials and Methods

There were seven AR-15 type rifles that were used in this research that were obtained from the Charlotte-Mecklenburg Police Department Property Control Bureau and the Crime Laboratory Reference Collection. The firearms that were used in this research project include:



Figure 2: Boltface Bushmaster 2

- 2 Bushmaster Carbon-15 rifles
- 2 Olympic Arms MFR rifles
- 2 Smith & Wesson M&P15 rifles
- 1 Rock River Arms LAR-15 rifle

There were three brands of ammunition used in each of the rifles, all with brass cartridge cases:

- American Eagle-Federal 223 REM 55 grain FMJ
- Remington-UMC 223 REM 55 grain FMJ
- Winchester-Target 223 REM 55 grain FMJ.

The equipment that was used to document the data included:

- Nikon D800 camera, a Nikon 5700 camera
- Nikon SMZ-2T stereomicroscope
- Leica UFM4 comparison microscope with a DFC420 camera
- Leica FSC comparison microscope with a DFC420 camera
- Leica FSC comparison microscope with a DFC320 camera
- Leica Application Suite version 4.4 software.

The boltfaces of each rifle were documented and photographed. Each boltface had an extractor that was in the approximate ten to eleven o'clock position and an ejector that was in approximately the four o'clock position as viewed from the front (**Figures 1-7**).

Each set of cartridges that were cycled and fired in each of the seven rifles were engraved with the firearm and the ammunition information. Photographs were taken of each cartridge prior to being cycled or fired through the rifles. Three Winchester cartridges, three Federal cartridges, and three Remington cartridges were cycled in each of the seven rifles. Then, the three sets of cycled cartridges for each brand were photographed. These steps were then repeated with the cartridges that were fired in the seven rifles.



Figure 3: Boltface Olympic Arms 1



Figure 4: Boltface Olympic Arms 2



Figure 5: Boltface Smith-Wesson 1



Figure 6: Boltface Smith-Wesson 2



Figure 7: Boltface Rock River Arms 1

The cycled cartridges and the fired cartridge cases were examined thoroughly using a stereoscope and a comparison microscope. The extractor mark was indexed on the cycled cartridges and the fired cartridge cases with a blue permanent marker. The ejector mark was indexed on the cycled cartridges and the fired cartridge cases with a red permanent marker. Once rotation (striated marks located on the case head) was noted on either the cycled cartridges or the fired cartridge cases through the examination process, the position of the rotation on the case head was documented and then photographed. The cycled cartridges and fired cartridge cases that exhibited rotation marks were then compared to one another for each rifle that produced the rotation marks.

Observations

Bushmaster Carbon-15

The first Bushmaster Carbon-15 rifle had a total of eight cycled cartridges or fired cartridge cases that exhibited rotation marks on the case head. This firearm also produced rotation marks on the primer area of the fired cartridge cases. There were forty-seven inter-comparisons completed among the fired cartridge cases and the cycled cartridges that had rotation marks either on the primer or the case head. Twenty-one of those inter-comparisons could be identified to the same firearm. Five of those inter-comparisons were inconclusive, specifically they could neither be identified nor eliminated as having been fired in or passed through the action of the same firearm. Nineteen of the inter-comparisons either lacked reproducibility of rotation marks in the same area on the case heads, the rotation marks were on different areas of the case heads, or the headstamp hindered the reproducibility of the rotation marks (**Table 1**)(**Figure 8**).

The second Bushmaster Carbon-15 rifle had a total of four cycled cartridges or fired cartridge cases that exhibited rotation marks. There were five inter-comparisons completed among the fired cartridge cases and the cycled cartridges that had rotation marks on the case heads. There were no identifications made among the inter-comparisons. There was one inter-comparison that was inconclusive, meaning they could neither be identified nor eliminated as to having been fired in or passed through the action of the same firearm. Four of the inter-comparisons either lacked reproducibility of rotation marks in the same area on the case heads, the rotation marks were on different areas of the case heads, or the headstamp hindered the reproducibility of the rotation marks (**Table 2, Figure 9**).

Olympic Arms MFR

The first Olympic Arms MFR rifle had a total of seventeen

cycled cartridges or fired cartridge cases that exhibited rotation marks. There were one hundred and thirty-five inter-comparisons completed among the fired cartridge cases and the cycled cartridges that exhibited rotation marks on the case heads. Ten of those inter-comparisons could be identified to the same firearm. Seven of those inter-comparisons were inconclusive. One hundred and eighteen of those inter-comparisons either lacked reproducibility of rotation marks in the same area on the case heads, the rotation marks were on different areas of the case heads, or the headstamp hindered the reproducibility of the rotation marks (**Table 3, Figures 10-11**).

The second Olympic Arms MFR rifle had a total of eleven cycled cartridges or fired cartridge cases that exhibited rotation marks. There were fifty-one inter-comparisons completed among the fired cartridge cases and the cycled cartridges that exhibited rotation marks on the case heads. Twenty-eight of those inter-comparisons could be identified to the same firearm. Six of those inter-comparisons were inconclusive. Seventeen of those inter-comparisons either lacked reproducibility of rotation marks in the same area on the case heads, the rotation marks were on different areas of the case heads, or the headstamp hindered the reproducibility of the rotation marks (**Table 4, Figures 12-13**).

Smith & Wesson M&P15

The first Smith & Wesson M&P rifle had a total of twelve cycled cartridges or fired cartridge cases that exhibited rotation marks. There were forty inter-comparisons completed among the fired cartridge cases and the cycled cartridges that exhibited rotation marks on the case heads. Three of those inter-comparisons could be identified to the same firearm. Eleven of those inter-comparisons were inconclusive. Twenty-six of those inter-comparisons either lacked reproducibility of rotation marks in the same area on the case heads, the rotation marks were on different areas of the case heads, or the headstamp hindered the reproducibility of the rotation marks (**Table 5, Figures 14-15**).

The second Smith & Wesson M&P rifle had a total of seven fired cartridge cases that exhibited rotation marks. There were fifteen inter-comparisons completed among the fired cartridge cases that exhibited rotation marks on the case heads. Three of those inter-comparisons could be identified to the same firearm. There were no inconclusive results for the inter-comparisons. Twelve of those inter-comparisons either lacked reproducibility of rotation marks in the same area on the case heads, the rotation marks were on different areas of the case heads, or the headstamp hindered the reproducibility of the rotation marks (**Table 6, Figure 16**).

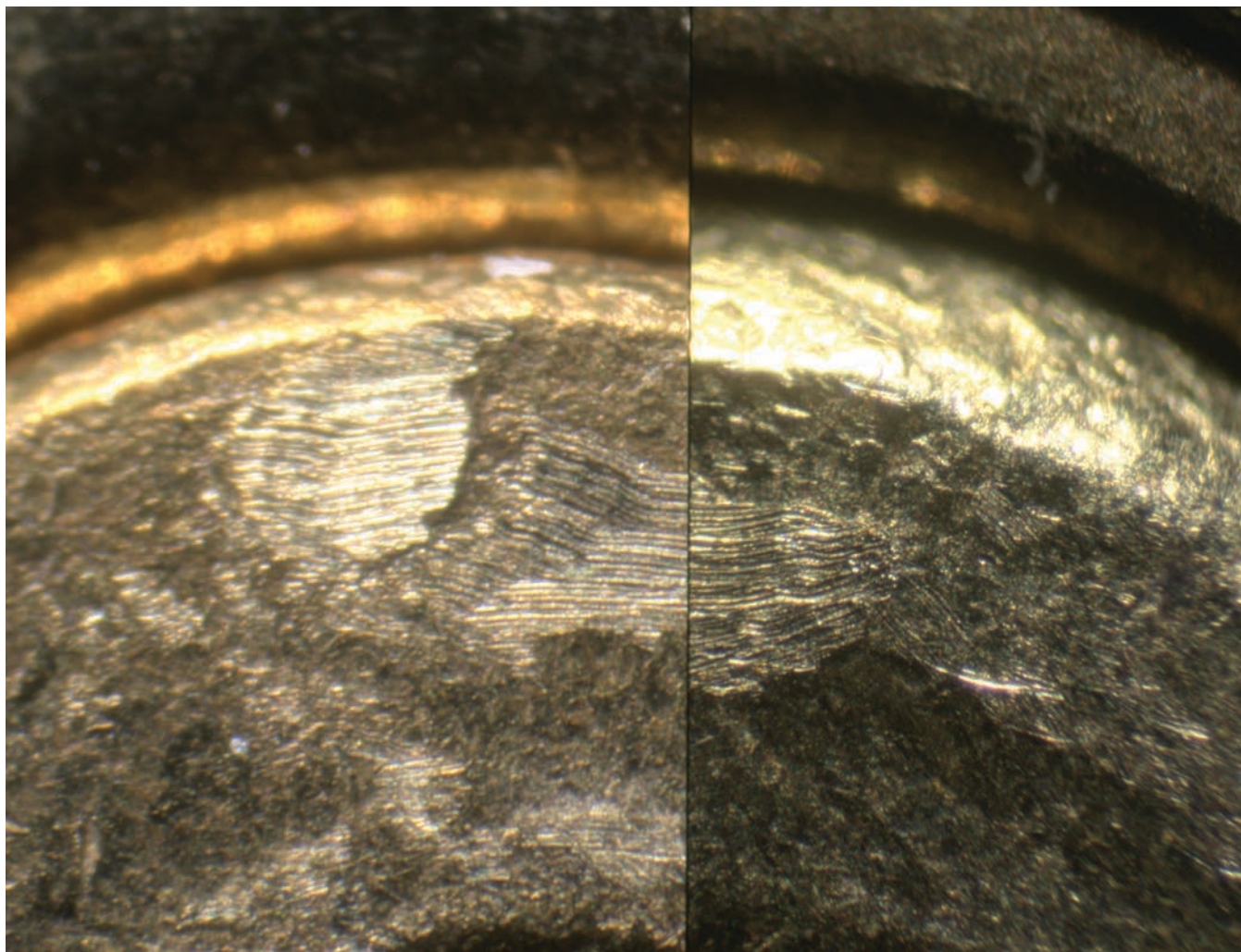


Figure 8: BM1-WIN F1 to FED F2-40X Identification

	Exhibit Rotation Marks Test 1	Suitable?	Exhibit Rotation Marks Test 2	Suitable?	Exhibit Rotation Marks Test 3	Suitable?
Fired Federal	no	no	yes	yes	yes	yes
Cycled Federal	no	no	no	no	no	no
Fired Remington	no	no	no	no	yes	no
Cycled Remington	no	no	yes	yes	no	no
Fired Winchester	yes	no	no	no	yes	no
Cycled Winchester	yes	yes	yes	no	no	no

Table 1: Bushmaster 1 Firearm

Rock River Arms LAR-15

The Rock River Arms LAR-15 rifle had a total of twelve cycled cartridges or fired cartridge cases that exhibited rotation marks. There were twenty-eight inter-comparisons completed among the fired cartridge cases and the cycled cartridges that exhibited rotation marks on the case heads. Fifteen of those inter-comparisons could be identified to the same firearm. Eight of those inter-comparisons were inconclusive. Five of those inter-comparisons either lacked reproducibility of rotation marks in the same area on the case heads, the rotation marks were on different areas of the case heads, or the headstamp hindered the reproducibility of the rotation marks (**Table 7, Figures 17-18**).

Results/Discussion

As a result of this study it was determined that rotation marks on the case heads can be found on both cycled cartridges and fired cartridge cases from all of the rifles. The rotation marks that are produced by a particular rifle can still be useful information for a firearm examiner. In cases where a firearm is not present, the rotation marks can be used to conclude that the cartridges or fired cartridge cases passed through the action of the same firearm. In cases where a firearm is present, it may be possible to determine that the fired cartridge cases were fired in that firearm by cycling tests through the firearm, when there is an absence of other types of marks. There are several possible reasons why the rotation marks may or may not produce well, or at all, in either the cycled cartridges or fired cartridge cases. One reason could be the type of ammunition that was used in the firearm. Another reason could be the finishing processes on the boltface of a particular rifle.

The three brands of ammunition that were used all exhibited rotation marks on the case heads through cycling the cartridge and/or firing the cartridge in the rifles. There were one-hundred-twenty-six cartridges that were used in this research. Seventy cartridges, or 55.6%, displayed rotation marks on the fired cartridge cases or the cycled cartridges. Fifty-six cartridges, or 44.4%, did not display any rotation marks on the fired cartridge cases or the cycled cartridges. Out of the seventy cartridges that exhibited rotation marks on the case heads, forty-two (60%) had suitable rotation marks that were usable for comparisons. The cartridges that were fired in the firearms produced more rotation marks than the cartridges that were cycled through the firearms. The composition of the brass and the positioning and the design of the headstamp may play a role in how well the rotation mark reproduced on the case head.

The Federal ammunition had the most suitable stria for

comparison. Twenty-one of the cycled and fired cartridges (50%) were suitable for comparison. There were eighteen fired cartridge cases (86%) with rotation marks on the case heads, seventeen of which (94%) were suitable for comparison. There were seven cycled cartridges (33%) with rotation marks on the case heads, four of which (57%) were suitable for comparison (**Tables 8, 9**).

The Remington ammunition had twelve cycled and fired cartridges (29%) that were suitable for comparisons. There were sixteen fired cartridge cases (76%) with rotation marks on the case heads, eight of which (50%) were suitable for comparison. There were nine cycled cartridges (43%) with rotation marks on the case heads, four of which (44%) were suitable for comparison (**Tables 10, 11**).

The Winchester ammunition had nine cycled and fired cartridges (21%) that were suitable for comparisons. There were thirteen fired cartridge cases (62%) with rotation marks on the case heads, six of which (46%) were suitable for comparison. There were eight cycled cartridges (38%) with rotation marks on the case heads, three of which (38%) were suitable for comparison (**Tables 12, 13**).

The rotation marks that were observed were predominately located in the area where the case head comes into contact with the extractor and ejector apertures on the boltface. The rotation marks that were observed on the case heads in the approximate two to three o'clock position are a result of the extractor or extractor aperture contacting the case head during the unlocking of the bolt either through cycling or firing. The rotation marks could have been caused by a sharp edge on the extractor or the extractor aperture; this could have been created during the finishing process or the use and abuse of the firearm. The rotation marks could also be a result of a defect where there is brass buildup on the extractor or extractor aperture which create marks on the case head during the locking or unlocking of the bolt. The rotation marks could also be a result of how the case head contacts the extractor face, which is flush with the boltface during the locking or unlocking of the bolt. The extractor face, which is adjacent to the bolt face, could be protruding at a slight angle and/or not flush with the bolt face (**Figure 19**).

The rotation marks that were observed on the case heads in the approximate seven to nine o'clock position are a result of the ejector or the ejector aperture coming in contact with the case head during the unlocking of the bolt either through firing or cycling. These marks could be a result from the ejector or ejector aperture not being de-burred during the manufacturer's finishing process. The ejector or ejector aperture not being de-burred could leave a sharp point or a

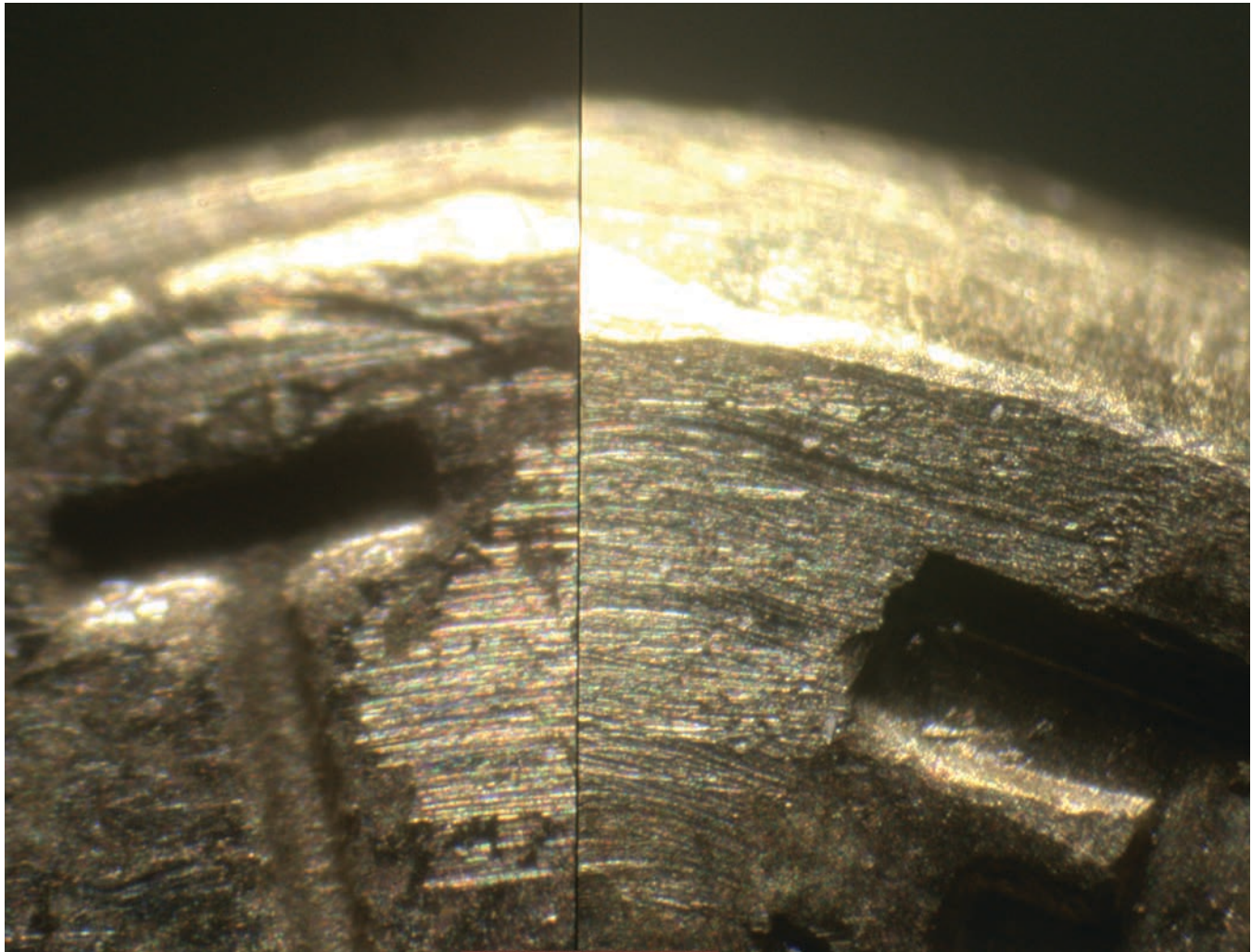


Figure 9: BM2-C3 WIN to F3 FC-40X Inconclusive

	Exhibit Rotation Marks Test 1	Suitable?	Exhibit Rotation Marks Test 2	Suitable?	Exhibit Rotation Marks Test 3	Suitable?
Fired Federal	no	no	yes	yes	yes	yes
Cycled Federal	no	no	no	no	no	no
Fired Remington	no	no	no	no	no	no
Cycled Remington	no	no	no	no	no	no
Fired Winchester	no	no	no	no	yes	no
Cycled Winchester	no	no	no	no	yes	no

Table 2: Bushmaster 2 Firearm

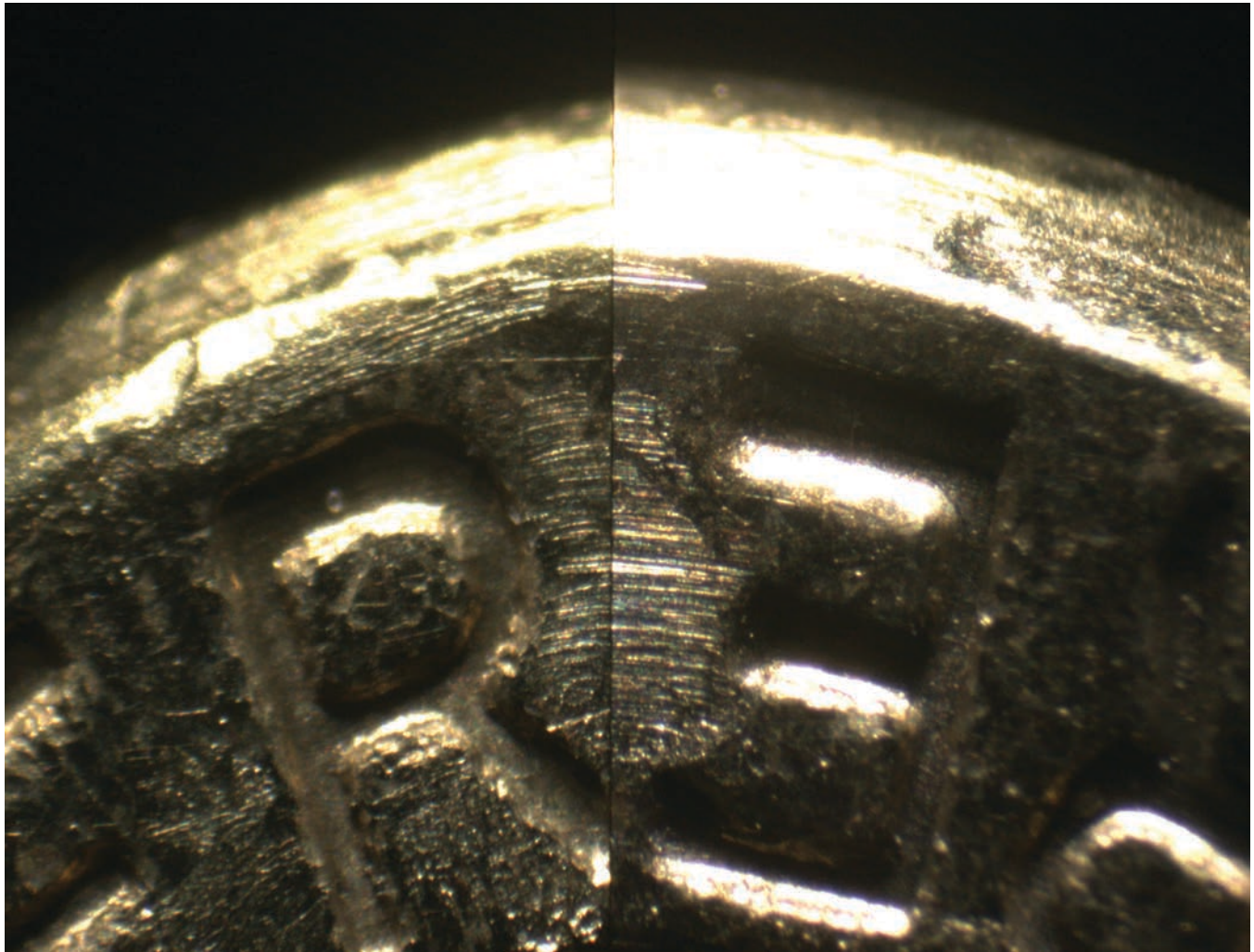


Figure 10: OA1 F1 WIN to C2 WIN-30X Identification

	Exhibit Rotation Marks Test 1	Suitable?	Exhibit Rotation Marks Test 2	Suitable?	Exhibit Rotation Marks Test 3	Suitable?
Fired Federal	yes	no	yes	yes	yes	yes
Cycled Federal	yes	yes	yes	yes	yes	yes
Fired Remington	yes	no	yes	no	yes	no
Cycled Remington	yes	no	yes	no	yes	no
Fired Winchester	yes	yes	no	no	yes	yes
Cycled Winchester	yes	no	yes	yes	yes	no

Table 3: Olympic Arms 1 Firearm

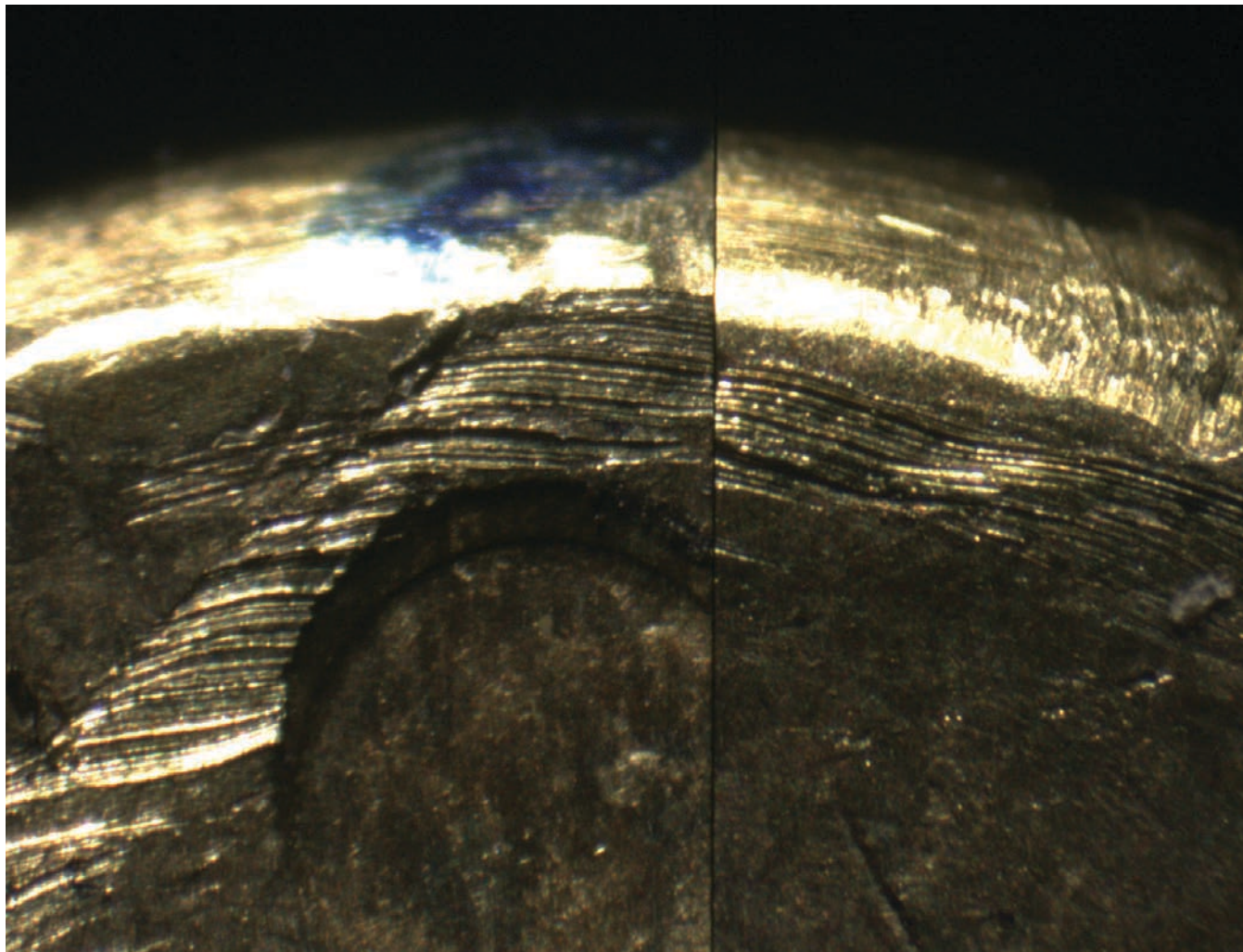


Figure 11: OA1 F3 to F2 FC-30X Identification

defect on the edge of the ejector or ejector aperture. As the bolt rotates to unlock, the ejector, being under spring tension, pushes against the case head. A burr or defect on the ejector or ejector aperture could create the rotation marks that are left on the case head. As a result of the firearm being fired and not cleaned, buildup of metal from the cartridge can deposit in the crevices of the extractor aperture and ejector aperture on the boltface. This may also create rotation marks on the case head from the ejector aperture and extractor aperture. One of the Bushmaster Carbon-15 rifles produced rotation marks that could have been caused by a defect or burr on the boltface of this rifle. The defect or burr was located in the approximate ten to eleven o'clock position on the boltface of this firearm (Figure 1). The Rock River Arms LAR-15 rifle had a buildup of brass near the extractor and the ejector which could indicate a defect or burr on the boltface (Figure 7).

Summary

Rotation marks were unable to be associated with only the fired cartridge cases that had been fired in the rifles. Bolt rotation marks were observed on both the cycled cartridges and the fired cartridge cases. The rotation marks on the cycled cartridges and the fired cartridge cases were predominately noted on the case heads where the extractor or extractor aperture and ejector or ejector aperture came in contact with the cartridge. Most of the rotation marks that were produced on the cycled cartridges and the fired cartridge cases could be used for either indexing or determining that the cartridges had passed through the action of the same firearm. This research used only a small portion of the AR-15 type rifles that are currently in circulation. Further studies could be completed using different AR-15 rifle manufacturers and other brands of ammunition to help further gather information for firearm examiners.

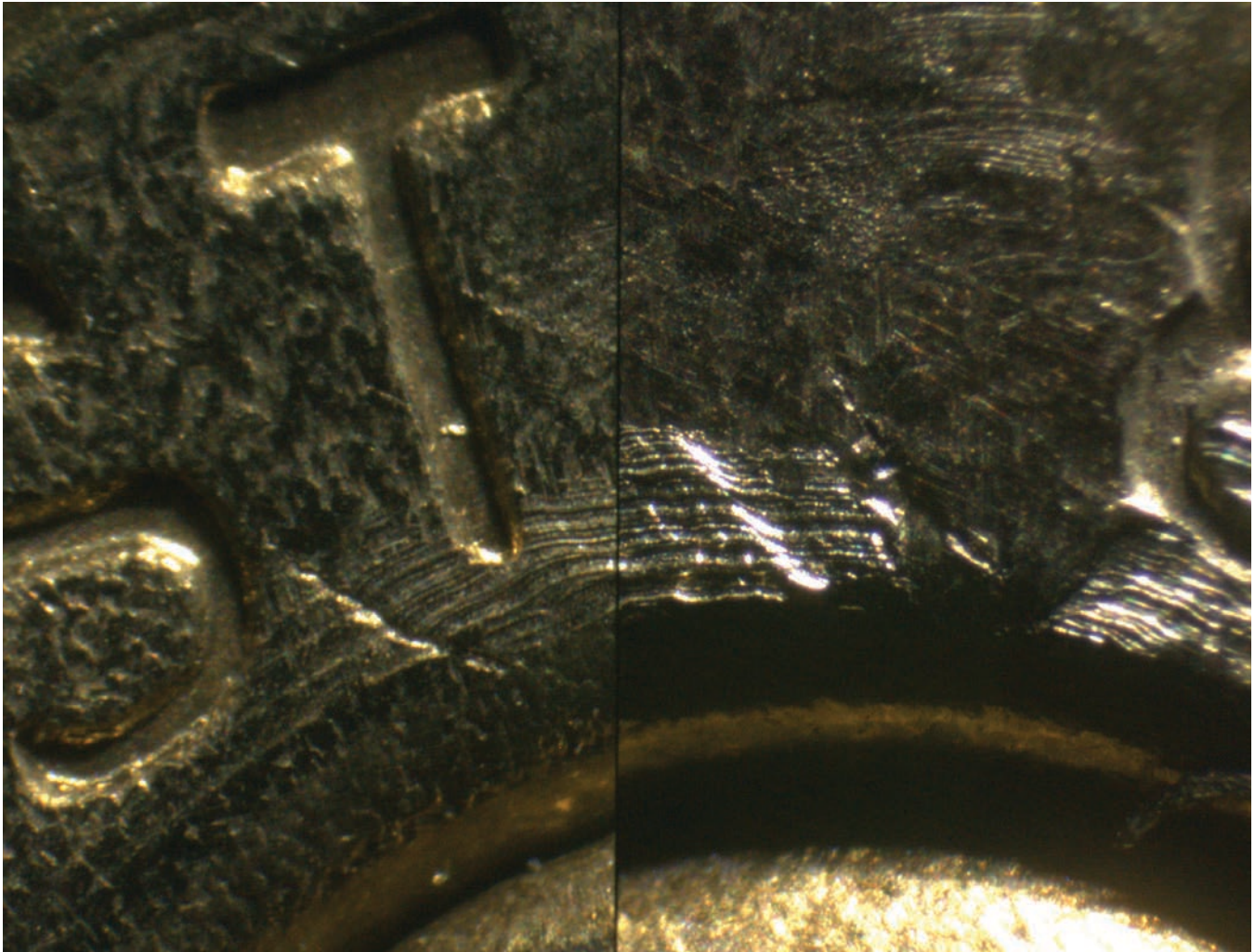


Figure 12: OA2 F2 to F3-WIN-30X Identification

	Exhibit Rotation Marks Test 1	Suitable?	Exhibit Rotation Marks Test 2	Suitable?	Exhibit Rotation Marks Test 3	Suitable?
Fired Federal	no	no	yes	yes	yes	yes
Cycled Federal	no	no	no	no	no	no
Fired Remington	yes	yes	yes	yes	yes	yes
Cycled Remington	yes	yes	no	no	yes	no
Fired Winchester	yes	no	yes	yes	yes	yes
Cycled Winchester	no	no	yes	yes	no	no

Table 4: Olympic Arms 2 Firearm

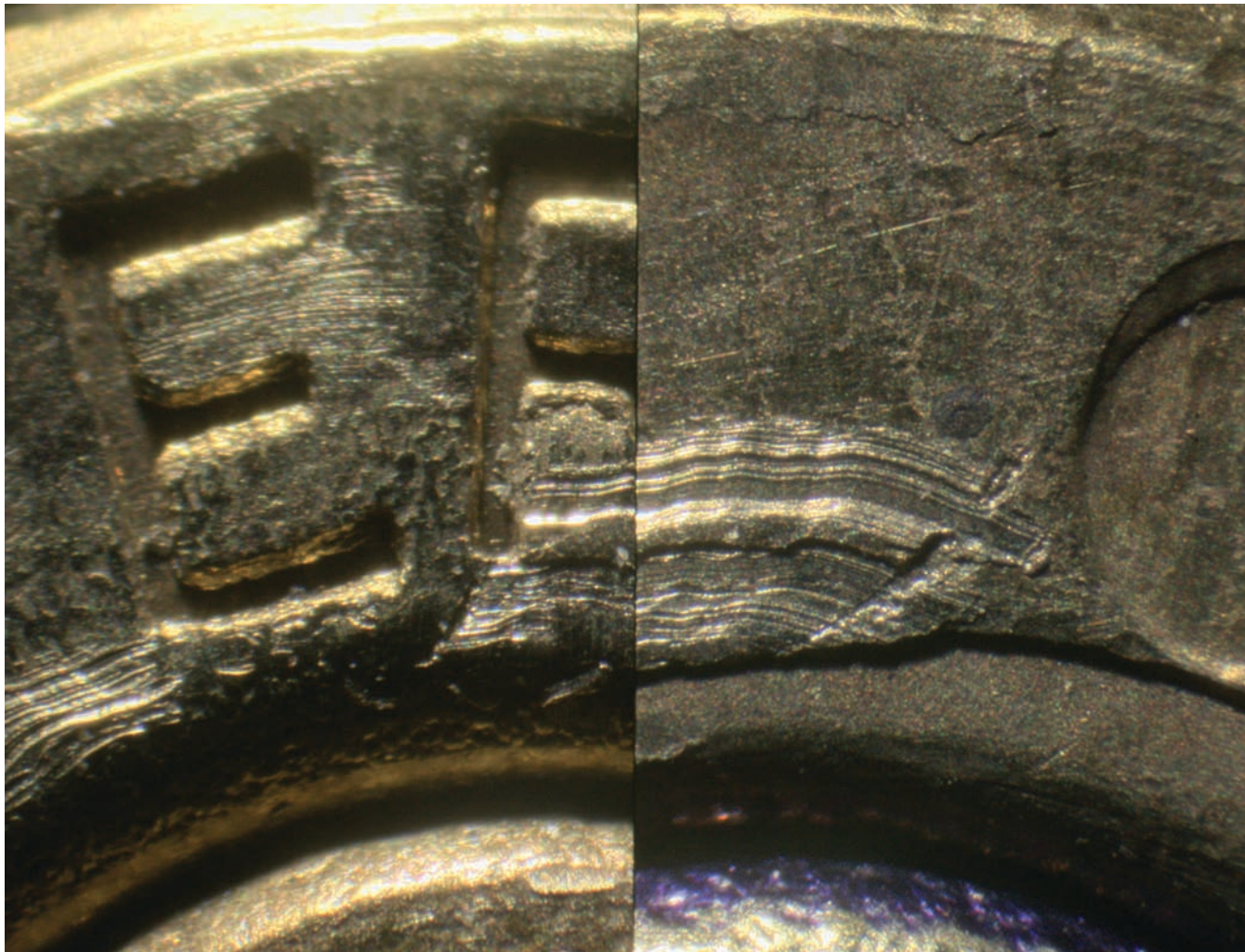


Figure 13: OA2-F3 WIN to F3 FC-30X Identification

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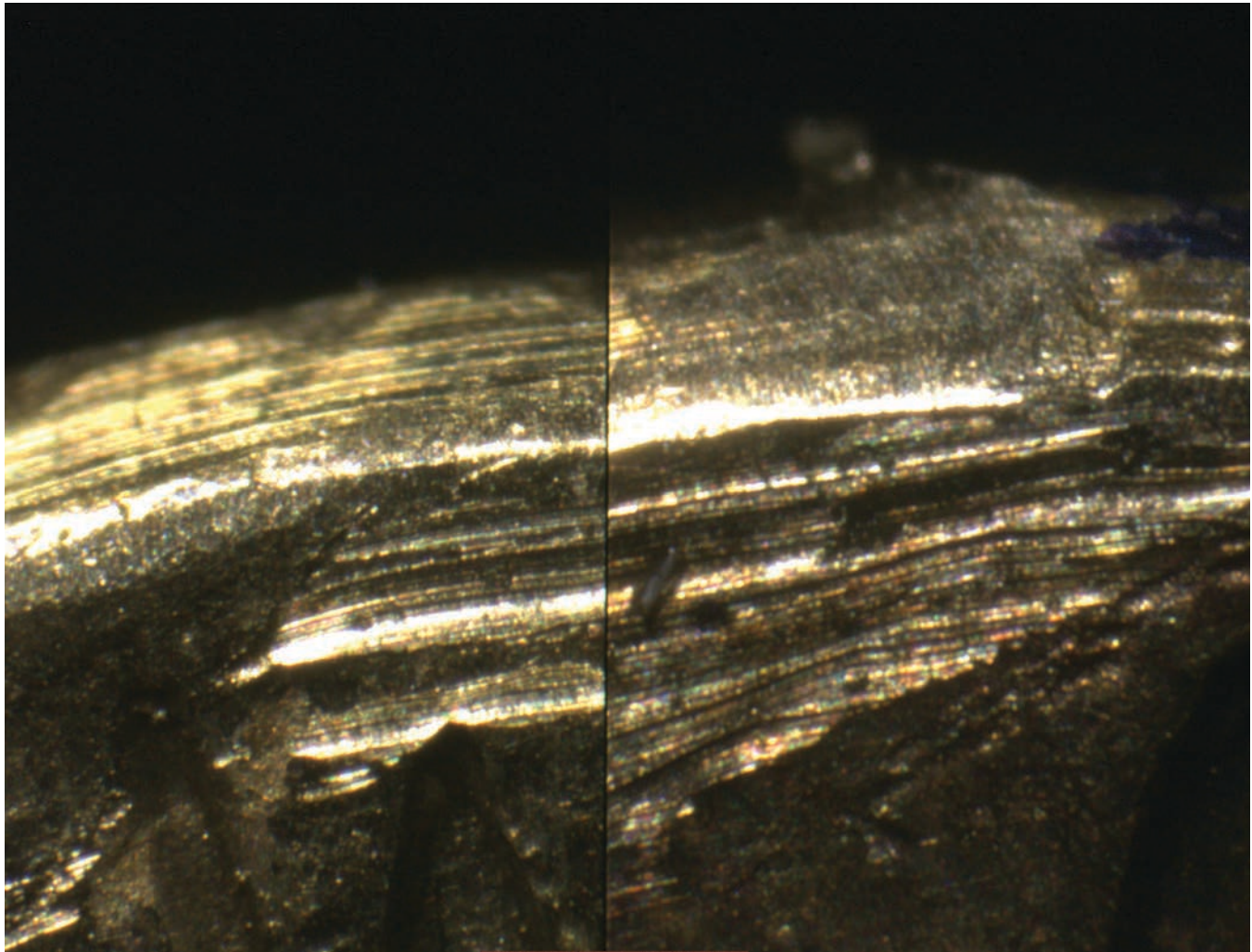


Figure 14: SW1-F1 WIN to F1 FC-40X Identification

	Exhibit Rotation Marks Test 1	Suitable?	Exhibit Rotation Marks Test 2	Suitable?	Exhibit Rotation Marks Test 3	Suitable?
Fired Federal	yes	yes	yes	yes	yes	yes
Cycled Federal	no	no	yes	no	yes	yes
Fired Remington	yes	no	yes	no	yes	yes
Cycled Remington	yes	yes	yes	yes	no	no
Fired Winchester	yes	no	no	no	no	no
Cycled Winchester	no	no	no	no	yes	no

Table 5: Smith & Wesson 1 Firearm

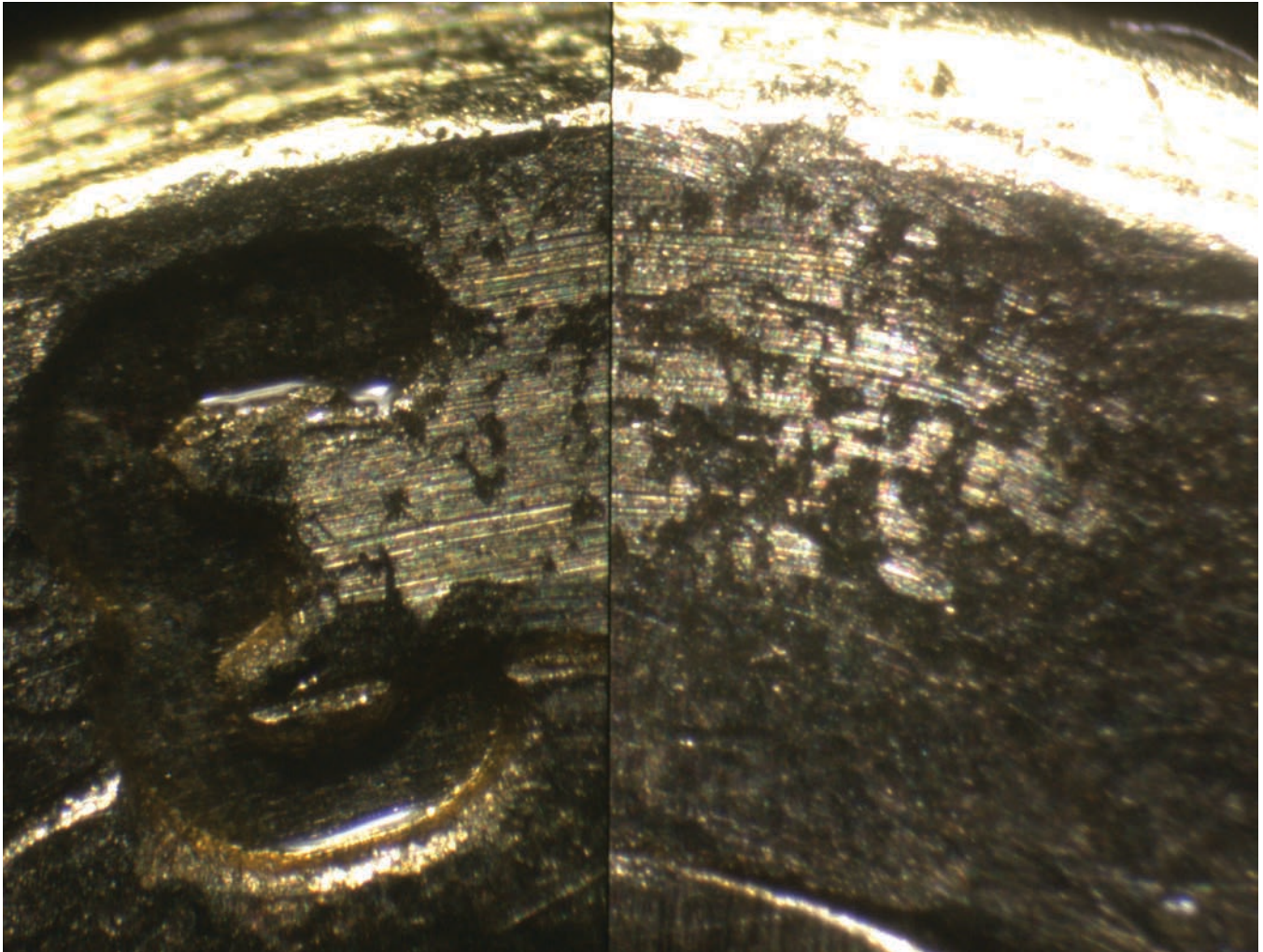


Figure 15: SW1-C1 to C2-RP-40X Identification

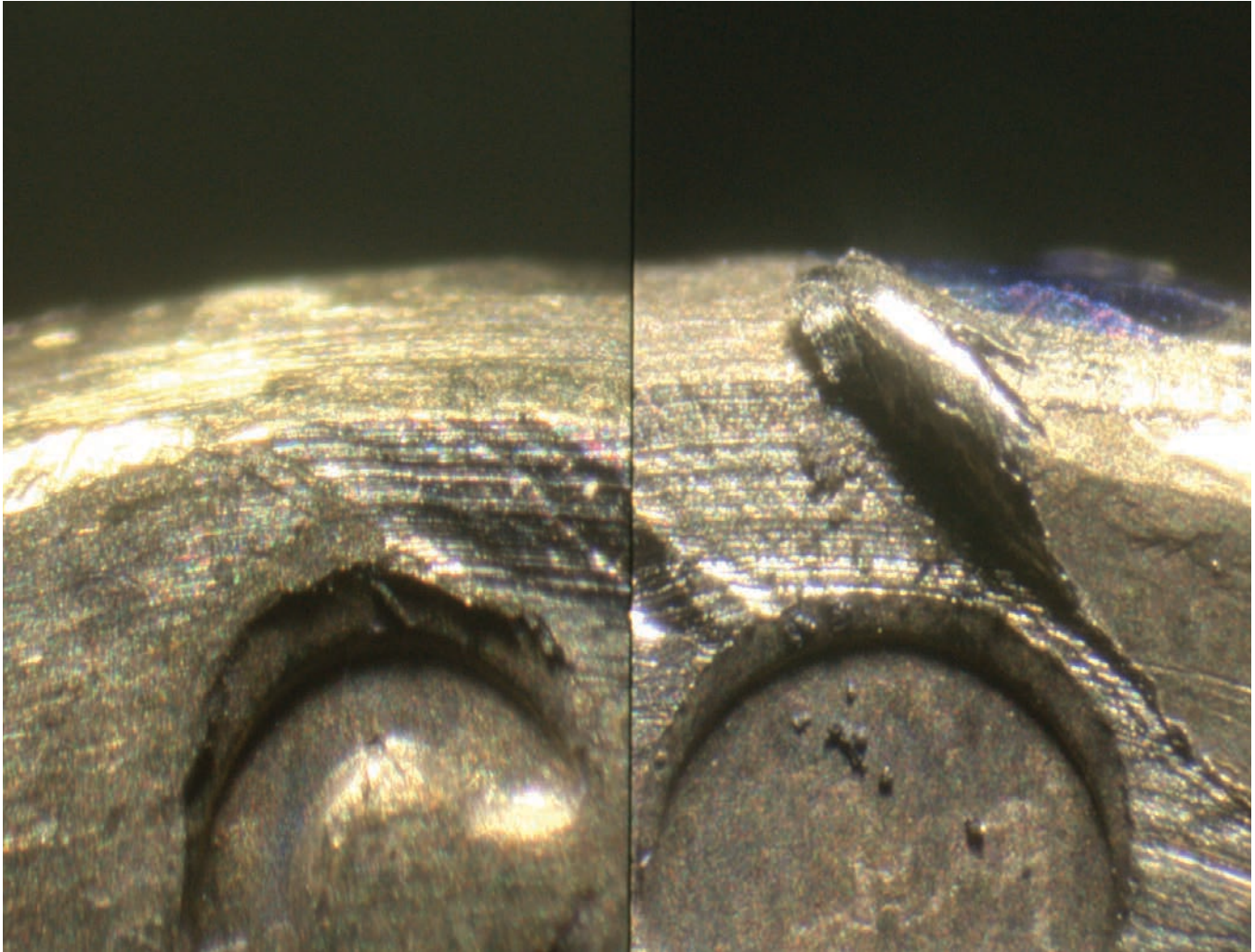


Figure 16: SW2-F2 FC to F3 FC-30X Identification

	Exhibit Rotation Marks Test 1	Suitable?	Exhibit Rotation Marks Test 2	Suitable?	Exhibit Rotation Marks Test 3	Suitable?
Fired Federal	yes	yes	yes	yes	yes	yes
Cycled Federal	no	no	no	no	no	no
Fired Remington	yes	no	yes	no	yes	yes
Cycled Remington	no	no	no	no	no	no
Fired Winchester	yes	no	no	no	no	no
Cycled Winchester	no	no	no	no	no	no

Table 6: Smith & Wesson 2 Firearm



Figure 17: RR1-F2 RP to F3 FC-30X Identification

	Exhibit Rotation Marks Test 1	Suitable?	Exhibit Rotation Marks Test 2	Suitable?	Exhibit Rotation Marks Test 3	Suitable?
Fired Federal	yes	yes	yes	yes	yes	yes
Cycled Federal	yes	no	no	no	yes	no
Fired Remington	yes	yes	yes	yes	yes	yes
Cycled Remington	no	no	no	no	yes	no
Fired Winchester	yes	yes	yes	no	yes	yes
Cycled Winchester	no	no	no	no	no	no

Table 7: Rock River Arms 1 Firearm

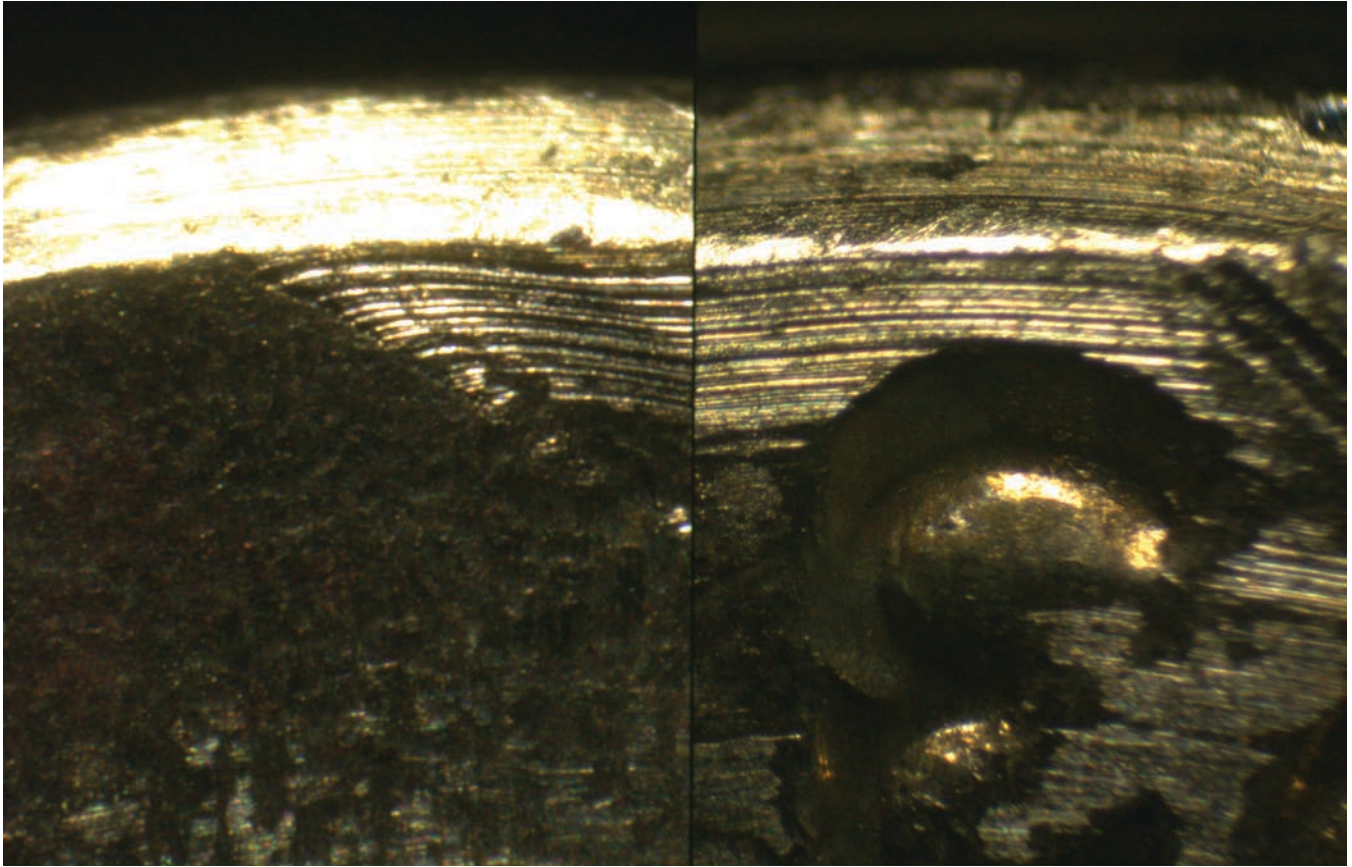


Figure 18: RR1 F2 RP to F1 WIN-40X Identification



Figure 19: Extractor Face

Firearm Manufacturer	Exhibit Rotation Marks F1	Suitable?	Exhibit Rotation Marks F2	Suitable?	Exhibit Rotation Marks F3	Suitable?
Bushmaster 1	no	no	yes	yes	yes	yes
Bushmaster 2	no	no	yes	yes	yes	yes
Olympic Arms 1	yes	no	yes	yes	yes	yes
Olympic Arms 2	no	no	yes	yes	yes	yes
Smith & Wesson 1	yes	yes	yes	yes	yes	yes
Smith & Wesson 2	yes	yes	yes	yes	yes	yes
Rock River Arms 1	yes	yes	yes	yes	yes	yes
Table 8: Federal-Fired Cartridge Cases						

Firearm Manufacturer	Exhibit Rotation Marks C1	Suitable?	Exhibit Rotation Marks C2	Suitable?	Exhibit Rotation Marks C3	Suitable?
Bushmaster 1	no	no	no	no	no	no
Bushmaster 2	no	no	no	no	no	no
Olympic Arms 1	yes	yes	yes	yes	yes	yes
Olympic Arms 2	no	no	no	no	no	no
Smith & Wesson 1	no	no	yes	no	yes	yes
Smith & Wesson 2	no	no	no	no	no	no
Rock River Arms 1	yes	no	no	no	yes	no
Table 9: Federal-Cycled Cartridges						

Firearm Manufacturer	Exhibit Rotation Marks F1	Suitable?	Exhibit Rotation Marks F2	Suitable?	Exhibit Rotation Marks F3	Suitable?
Bushmaster 1	no	no	no	no	yes	no
Bushmaster 2	no	no	no	no	no	no
Olympic Arms 1	yes	no	yes	no	yes	no
Olympic Arms 2	yes	yes	yes	yes	yes	yes
Smith & Wesson 1	yes	no	yes	no	yes	yes
Smith & Wesson 2	yes	no	yes	no	yes	yes
Rock River Arms 1	yes	yes	yes	yes	yes	yes

Table 10: Remington-Fired Cartridge Cases

Firearm Manufacturer	Exhibit Rotation Marks C1	Suitable?	Exhibit Rotation Marks C2	Suitable?	Exhibit Rotation Marks C3	Suitable?
Bushmaster 1	no	no	yes	yes	no	no
Bushmaster 2	no	no	no	no	no	no
Olympic Arms 1	yes	no	yes	no	yes	no
Olympic Arms 2	yes	yes	no	no	yes	no
Smith & Wesson 1	yes	yes	yes	yes	no	no
Smith & Wesson 2	no	no	no	no	no	no
Rock River Arms 1	no	no	no	no	yes	no

Table 11: Remington- Cycled Cartridges

Firearm Manufacturer	Exhibit Rotation Marks F1	Suitable?	Exhibit Rotation Marks F2	Suitable?	Exhibit Rotation Marks F3	Suitable?
Bushmaster 1	yes	no	no	no	yes	no
Bushmaster 2	no	no	no	no	yes	no
Olympic Arms 1	yes	yes	no	no	yes	yes
Olympic Arms 2	yes	no	yes	yes	yes	yes
Smith & Wesson 1	yes	no	no	no	no	no
Smith & Wesson 2	yes	no	no	no	no	no
Rock River Arms 1	yes	yes	yes	no	yes	yes

Table 12: Winchester-Fired Cartridge Cases

Firearm Manufacturer	Exhibit Rotation Marks C1	Suitable?	Exhibit Rotation Marks C2	Suitable?	Exhibit Rotation Marks C3	Suitable?
Bushmaster 1	yes	yes	yes	no	no	no
Bushmaster 2	no	no	no	no	yes	no
Olympic Arms 1	yes	no	yes	yes	yes	no
Olympic Arms 2	no	no	yes	yes	no	no
Smith & Wesson 1	no	no	no	no	yes	no
Smith & Wesson 2	no	no	no	no	no	no
Rock River Arms 1	no	no	no	no	no	no

Table 13: Winchester- Cycled Cartridges